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Snow Retrievals from the GPM Constellation

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Introduction

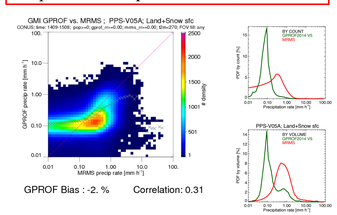
Unlike the GPM rainfall requirement which has specific accuracy metrics, the only GPM snow retrieval requirement is to demonstrate that snow retrieval *is* possible. The process of snow retrieval (frozen precipitation) is a product of the GPROF rainfall retrieval, whereas the total precipitation is computed using the GPROF Bayesian approach using an a-priori database from various input precipitation datasets matched to each sensors set of Tbs. For Version 5 of the GPM retrieval, these sources are the V4 Combined products over ocean, the V4 Ku rainrates over vegetated land, and the MRMS rain rates over snow covered surfaces. The Sims and Liu, (2015) method of parsing rain and snow based of the Surface Wet Bulb temperature is then applied, thus defining whether the GPROF retrieved precipitation is Liquid (rain) or Frozen (snow), or a mixture of both.

The GPM constellation includes sensors with greatly different channel frequency combinations, and while none of the other sensors match the extent of the GMI frequencies, the GPM mission is to retrieve precipitation from all the sensors. Using the snow/rain parsing technique we can produce from each, the snowfall rates – though they can be quite different! For this presentation, we'll concentrate the comparison on snowfall over land and snow covered surfaces - the retrievals over ocean are quite similar.

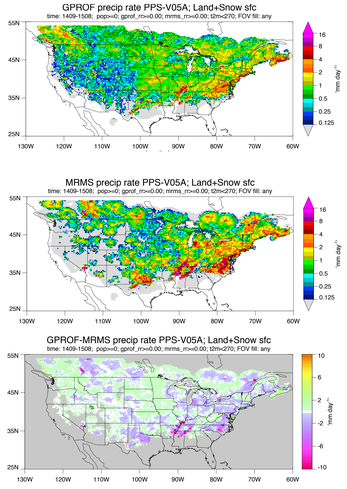
GMI Retrieval Compared with MRMS Precipitation

First, we'll present a comparison of GMI with MRMS only during GMI over passes, without the liquid/frozen parsing of the GPROF V5 GMI precipitation where 'frozen precipitation' is defined as precipitation falling where the surface 2 meter temperature is < 270 K. This includes one entire year of data from 09/2014 – 08/2015. The left section shows the result with all rain rates including non-raining, the right side is conditional on precipitation falling. The conditional rain shows a 35% negative bias for GMI, however as shown in the lower right difference plot, much of this difference is coming from the far south of the CONUS area. These areas were primarily NOT snow covered surfaces, and were areas where GPROF used the Ku rain rates as the a-priori database (which were known to be less than the MRMS radar derived precipitation). The rainfall PDF plots show shift towards lower rain rates for the GPROF retrieval. This is probably a result of the GPROF Bayesian process, while at the same time MRMS may not have the ability to observed the lighter snowfall rates.

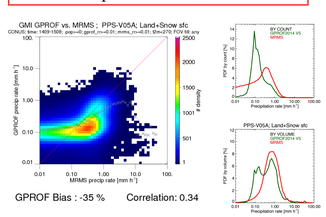
All pixels : Precipitation rate ≥ 0 mm h^{-1}



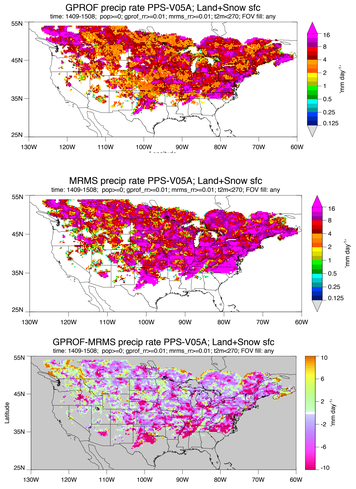
GPROF Bias : -2. % Correlation: 0.31



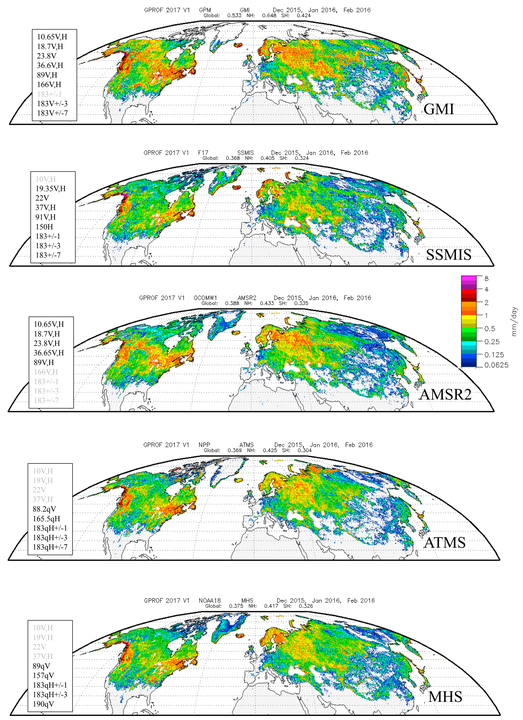
Pixels Precipitation rate ≥ 0.01 mm h^{-1}



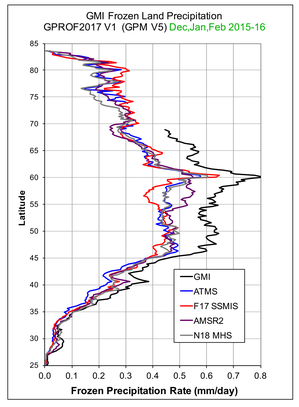
GPROF Bias : -35 % Correlation: 0.34



Constellation Sensors and Snow (Dec, Jan, Feb 2015-2016)

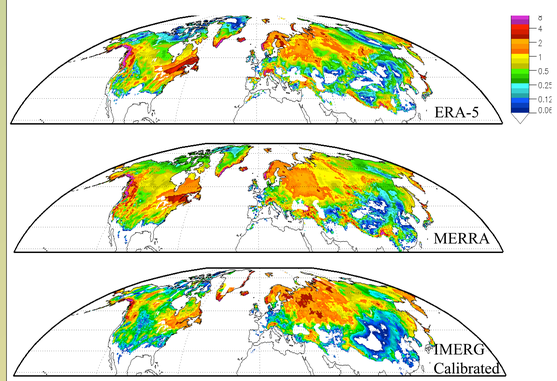


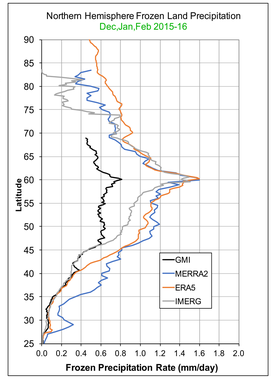
These plots are the GPROF retrieval of frozen precipitation (using the Wet Bulb Temperature parsing) from each of the GPM Constellation sensors for December, January, February (winter of 2015-2016). The various channel combination of each sensor is to the left of each plot. Though the magnitude can vary greatly regionally, the zonal averaged plots clearly shows GMI to be greater than the other sensors. Given the variability of the channels used in the retrieval, we find the pattern of snowfall is remarkably similar.



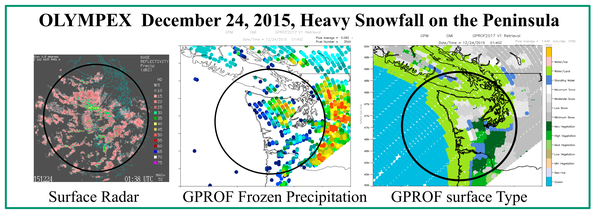
Model and IMERG Snow (Dec, Jan, Feb 2015-2016)

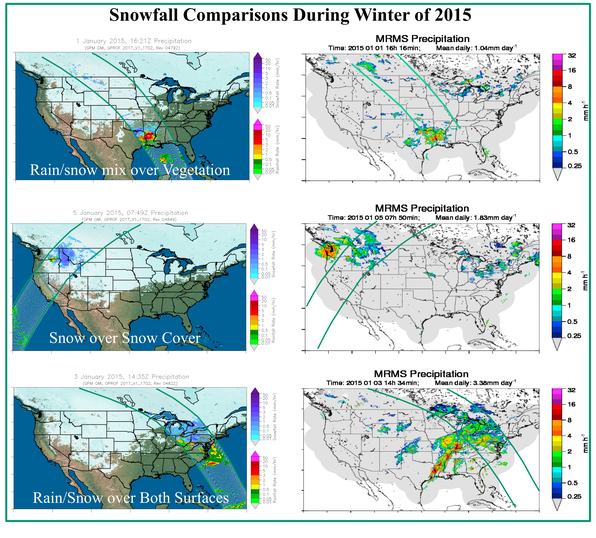
These are the ERA-5, MERRA and IMERG (calibrated) snowfall for the same three months shown above. The zonal mean snowfall are roughly double the satellite retrievals. The black line in both the zonal plots is the GMI retrieval.

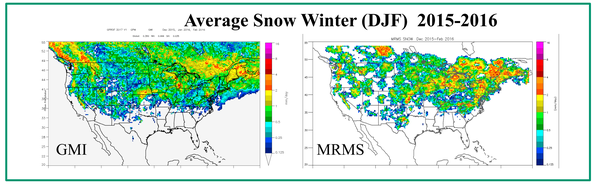




Case Studies







SUMMARY

This first look at the snowfall retrieval from the GPM constellation sensors shows the ability to successfully detect snow, though the magnitude of the retrieval varies widely between sensors. This is undoubtedly due to the channel lineup and footprint size of the sensors. There is much work still to be done to improve the inter-satellite consistency and to understand the error characteristics of the channels in relation to the GPROF retrieval. Not shown here are the pre-GPM sensors (SSMI, AMSRE, and AMSUB) . These have been shown to produce similar results to the other sensors and will enable us to move back in time to the beginning of the TRMM error.

The snow retrieval during OLYMPEX showed much less snow than measured from the ground. This was found to be caused by the model grid resolution whereby the higher altitude temperatures were much warmer than measured during the experiment thus causing the precipitation to be identified as rain instead of snow.

Snow was successfully retrieved during a variety of surface (vegetated and snow covered) and mixed rain/conditions.

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